

FIG. 1

COMPARISON BETWEEN CHARACTERISTICS OF KINETIC FUNCTION MATERIALS

	<u>HIGH POLYMER GEL</u> Ionic polymer-metal composites ⁽¹⁾ produced by freezing-de frosting method ⁽³⁾	SHAPE MEMORY ALLOY ⁽⁵⁾	PIEZOELECTRIC CERAMIC ELEMENT ⁽⁴⁾	RUBBER ARTIFICIAL MUSCLE ⁽⁴⁾	INTERCALATION MATERIAL ⁽²⁾	BIOMUSCLE ⁽³⁾
DISPLACEMENT	20 - 30%	8%	0.1%	20%	[Amino-TiNbO5] SEVERAL TIMES (REACTION DRIVE TYPE)	50%
FORCE (MPa)	10 - 30	-	588	300		
SPEED OF RESPONSE	>0.2 sec	sec to min	μ sec			0.03-0.2sec
DRIVE METHOD	APPLICATION OF VOLTAGE (4-7 V)	CHANGE IN SOLUTION TEMPERATURE	APPLICATION OF VOLTAGE (50-800V)	CHANGE IN PNEUMATIC PRESSURE	CHANGE IN SOLUTION (APPLICATION OF VOLTAGE)	
OUTPUT-WEIGHT RATIO	-	01. W/g	0.1W/g			0.1-0.3W/g
LABORATORY	NEW MEXICO UNIVERSITY	MECHANICAL TECHNOLOGY RESEARCH	NAGAOKA TECHNOLOGY/SCIENCE UNIVERSITY	BRIDGESTONE CORPORATION		

1 "Ionic Polymer-Metal Composites (IPMC) As Biomimetic Sensors, Actuators and Artificial Muscles-A Review"
M. Shahinpoor et al. (University of New-Mexico) <http://www.unm.edu/~amri/paper.html>

2 "ORGANIC INTERCALATION ON LAYERED COMPOUND KTINbO5" S.KIKKAWA and M.KOIZUMI (Osaka Univ.)
Physica 105B (1981) 234

3 "ARTIFICIAL MUSCLE", MAKOTO SUZUKI (MECHANICAL TECHNOLOGY RESEARCH), APPLIED PHYSICS, 60(1991)256

4 "ACTUATOR PRACTICAL DICTIONARY", SUPERVISED BY SHOUTAROU MIYAIRI, FUJI TECHNO SYSTEM (1988)

5 "ARTIFICIAL MUSCLE" EDITED BY HITOSHI MIYAKE, KAMEDA BOOK SERVICE (1998)

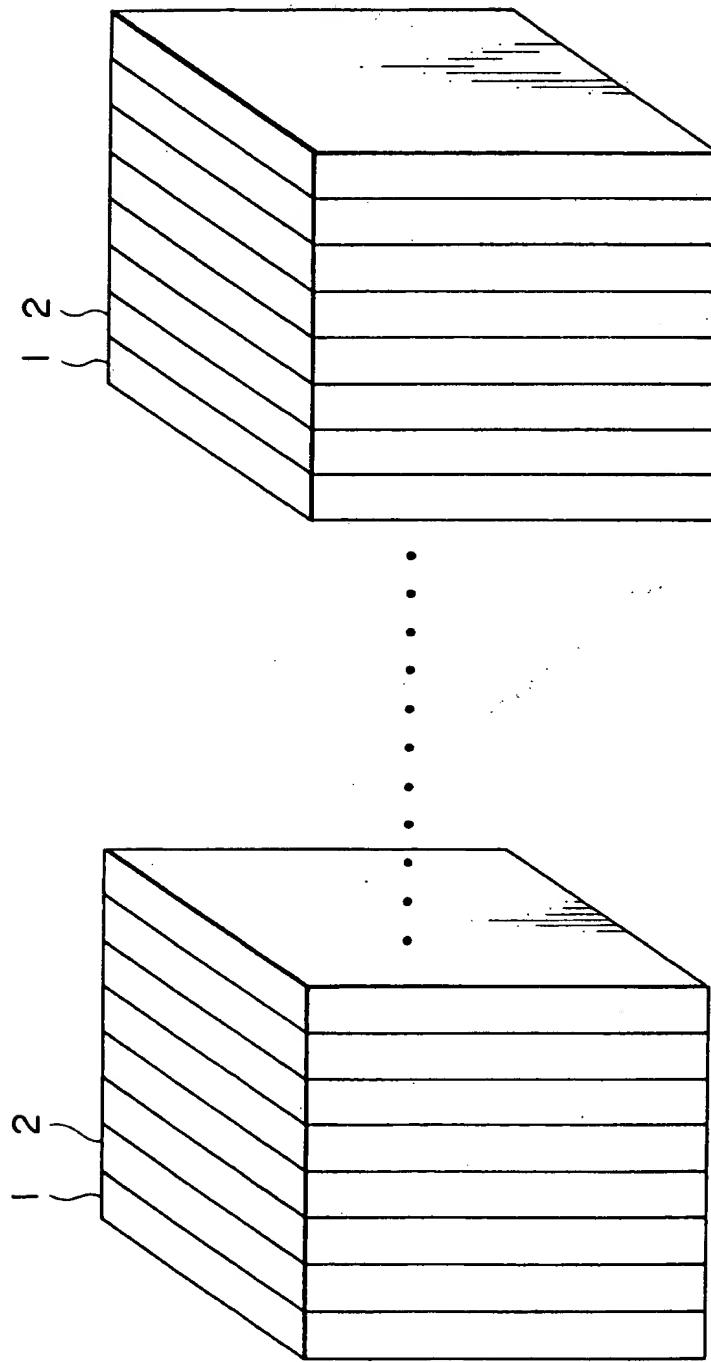


F I G . 2

DIFFERENCE BETWEEN ELECTROMAGNETIC WAVE
AND SOUND WAVE IN TERMS OF WAVELENGTH

	NAME OF SOUND WAVE (ULTRASONIC WAVE)	WAVE- LENGTH, λ	NAME OF ELECTRO- MAGNETIC WAVE	
1GHz	VERY HIGH FREQUENCY ULTRASONIC WAVE	380 nm	VISIBLE LIGHT RAY	
		780 nm	NEAR INFRARED RADIATION	
		1. 5 μ m	MID INFRARED RADIATION	
		5 μ m	FAR INFRARED RADIATION	
		100 μ m	VERY FAR INFRARED RADIATION	3THz
		1mm	MILLIMETER WAVE	300GHz
		1 cm	MICROWAVE	30GHz
		10 cm	SUPERHIGH HIGH FREQUENCY WAVE	3GHz
		1m	VERY HIGH FREQUENCY WAVE	300MHz
		10m	HIGH FREQUENCY WAVE	30MHz
20KHz	AUDIBLE SOUND WAVE (HIGH TEMPERATURE)			
20Hz	AUDIBLE SOUND WAVE (LOW TEMPERATURE) LOW FREQUENCY WAVE			

F | G. 3



F I G. 4

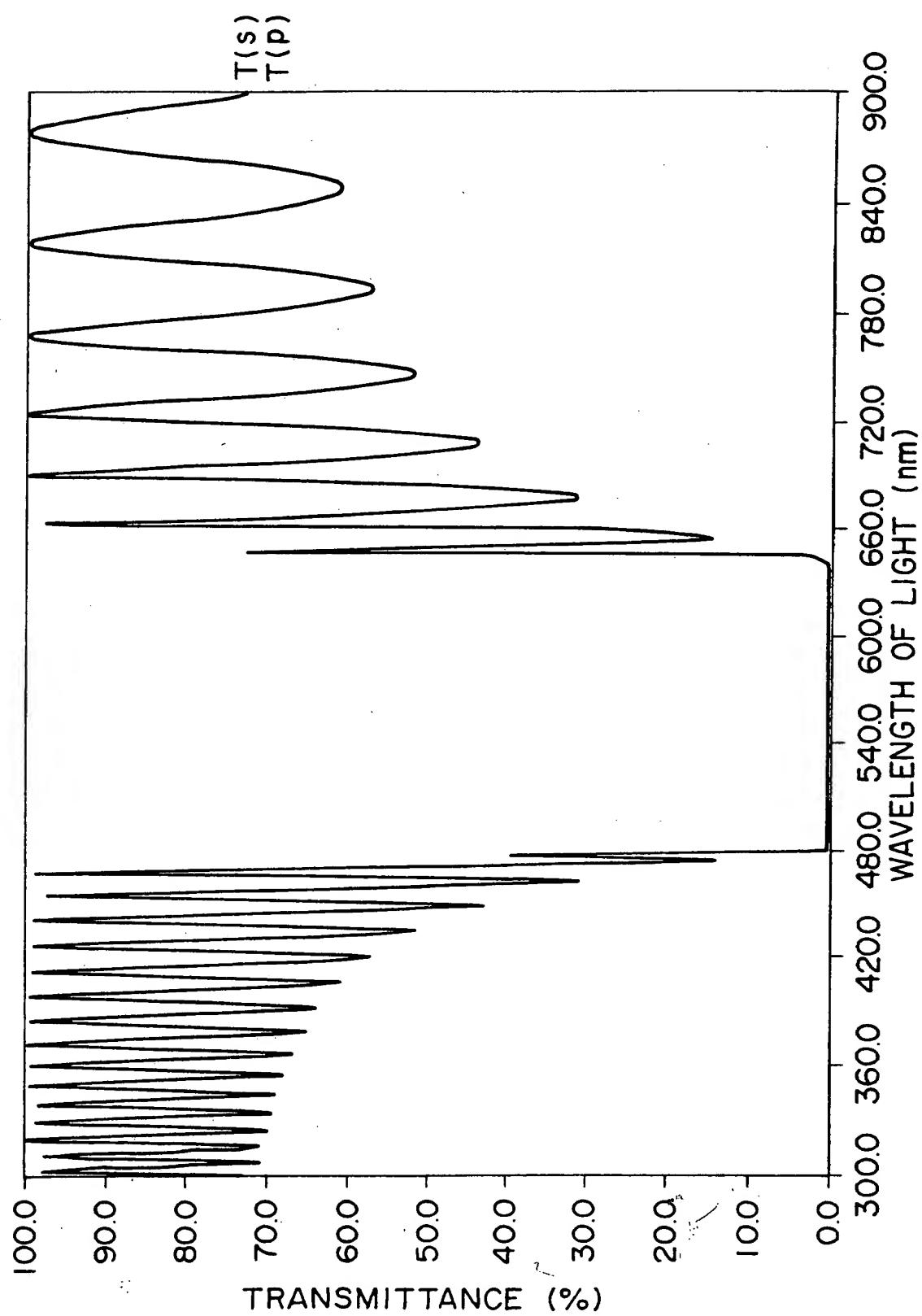


FIG. 5

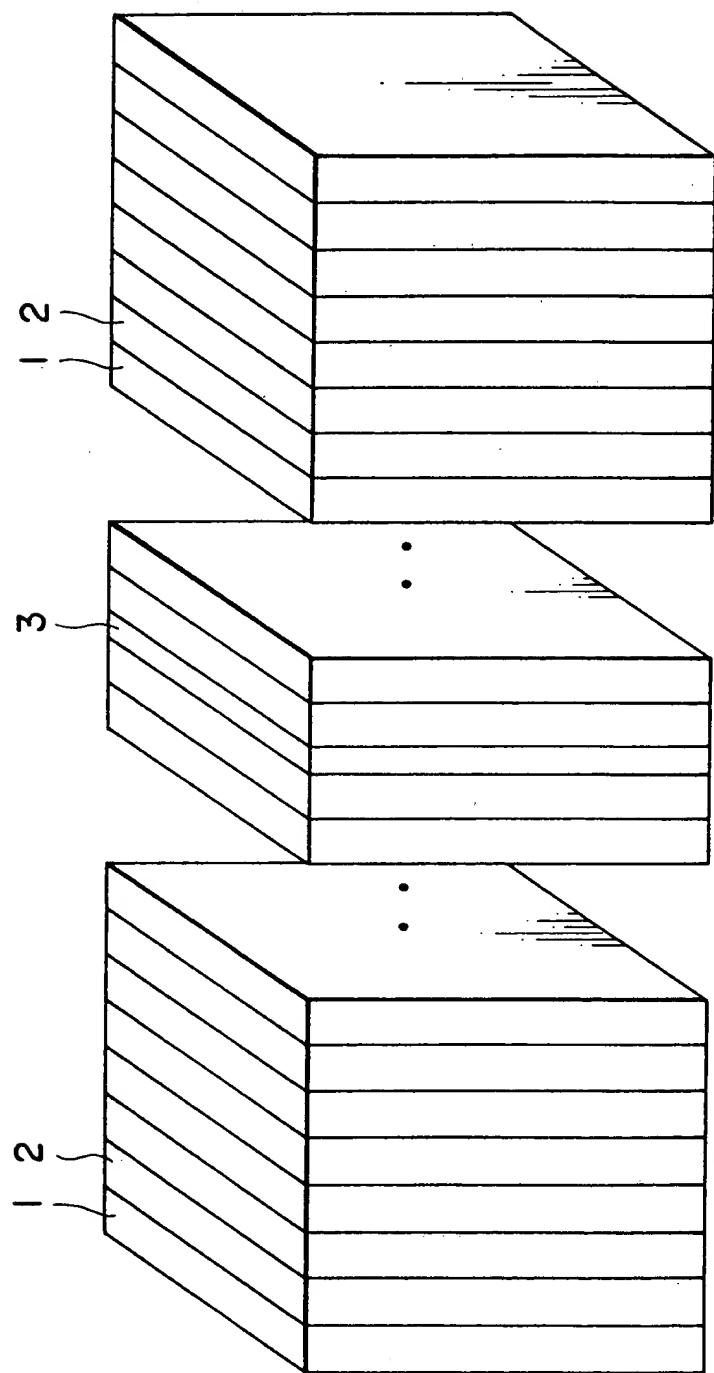


FIG. 6

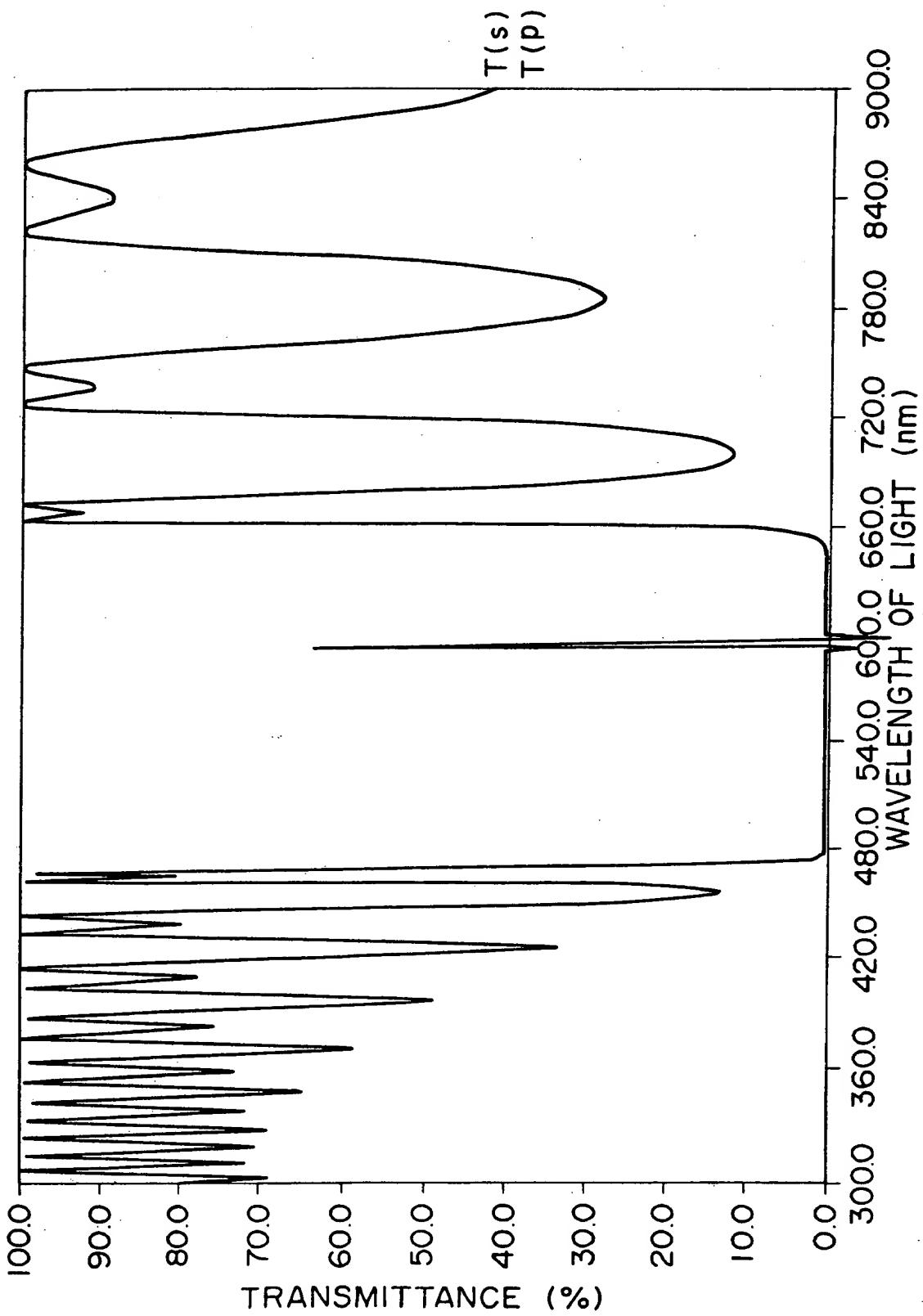


FIG. 7A

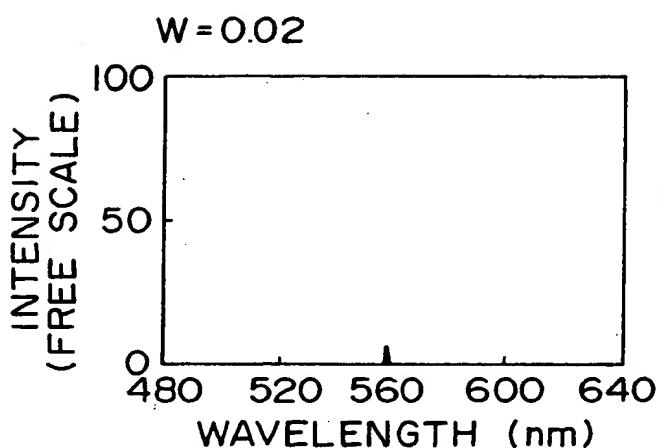


FIG. 7D

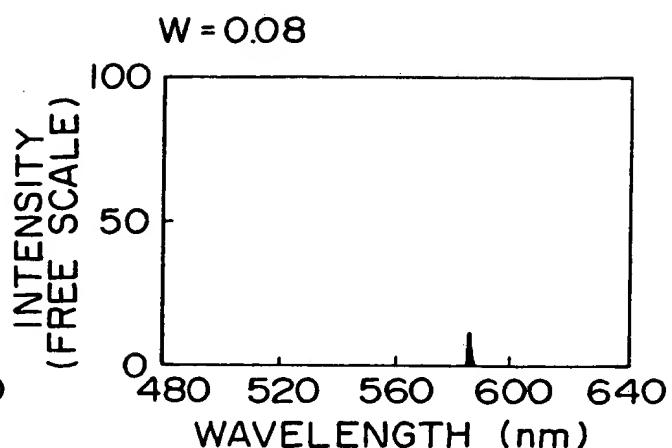


FIG. 7B

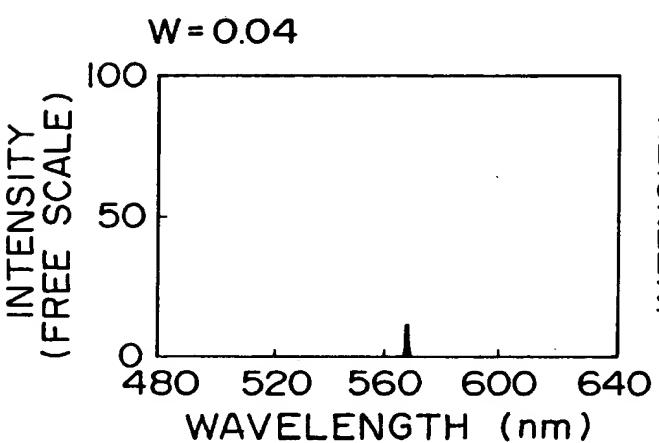


FIG. 7E

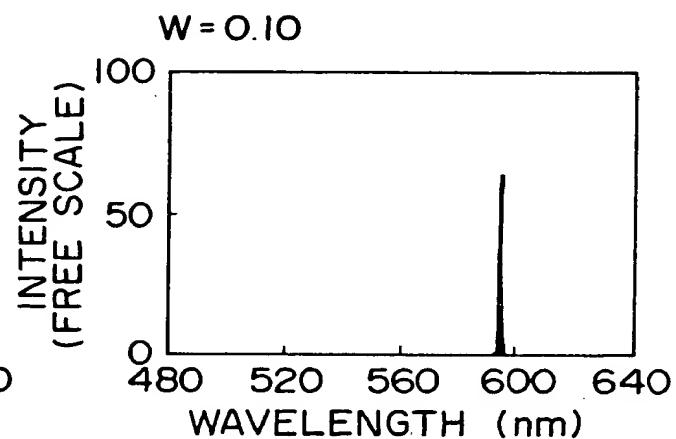


FIG. 7C

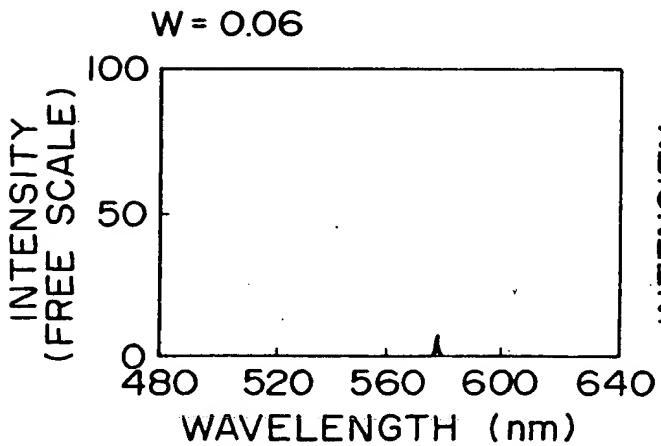


FIG. 7F

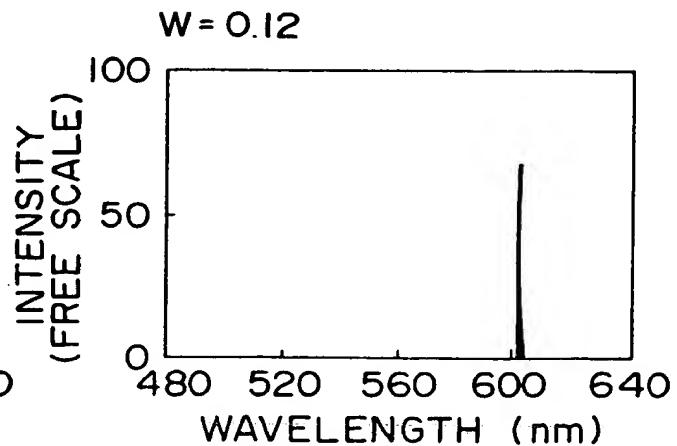


FIG. 8A

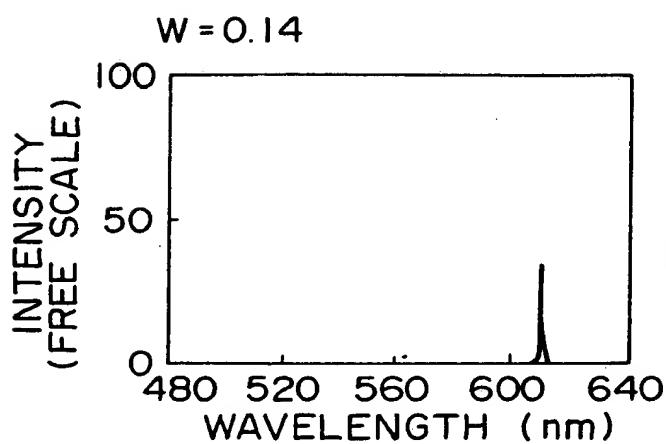


FIG. 8D

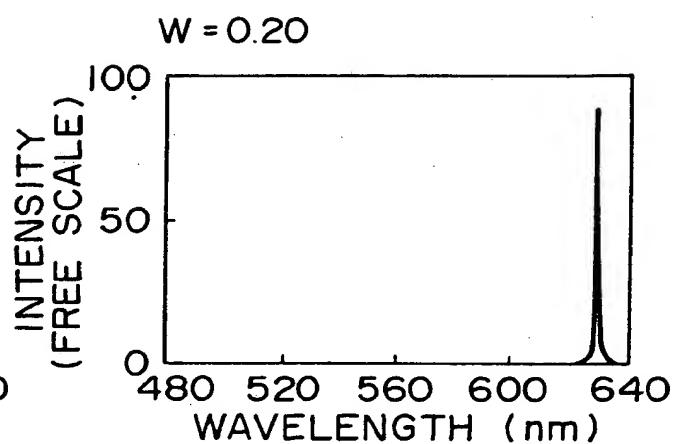


FIG. 8B

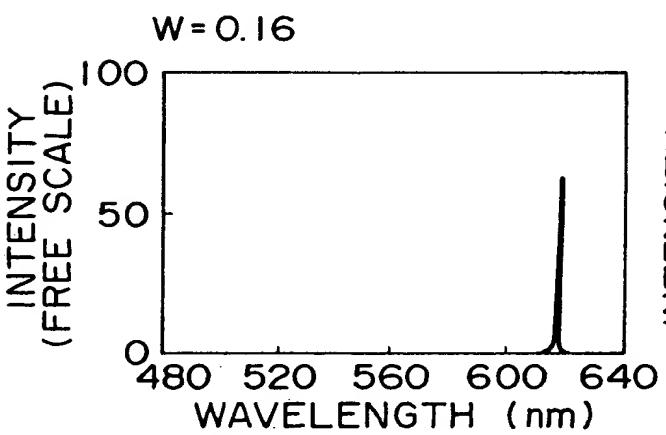


FIG. 8E

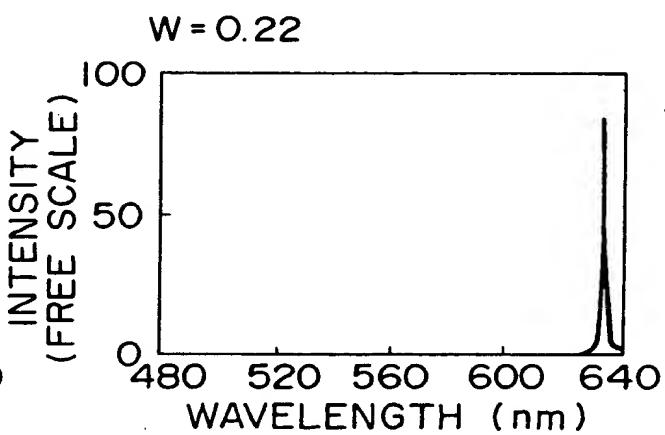


FIG. 8C

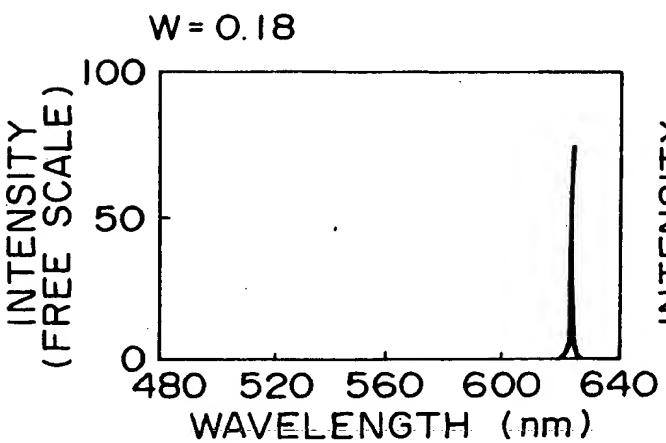
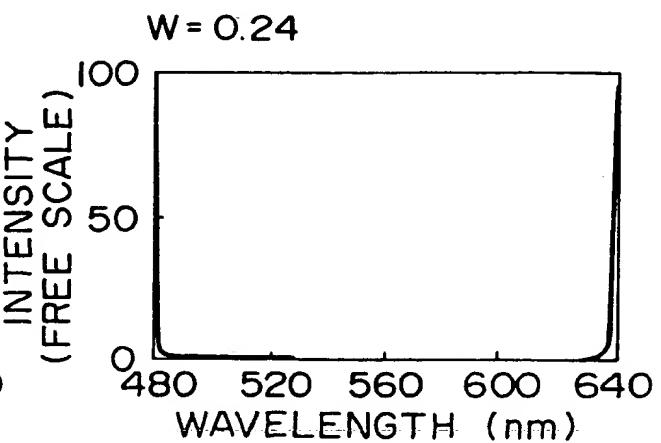


FIG. 8F



F I G . 9

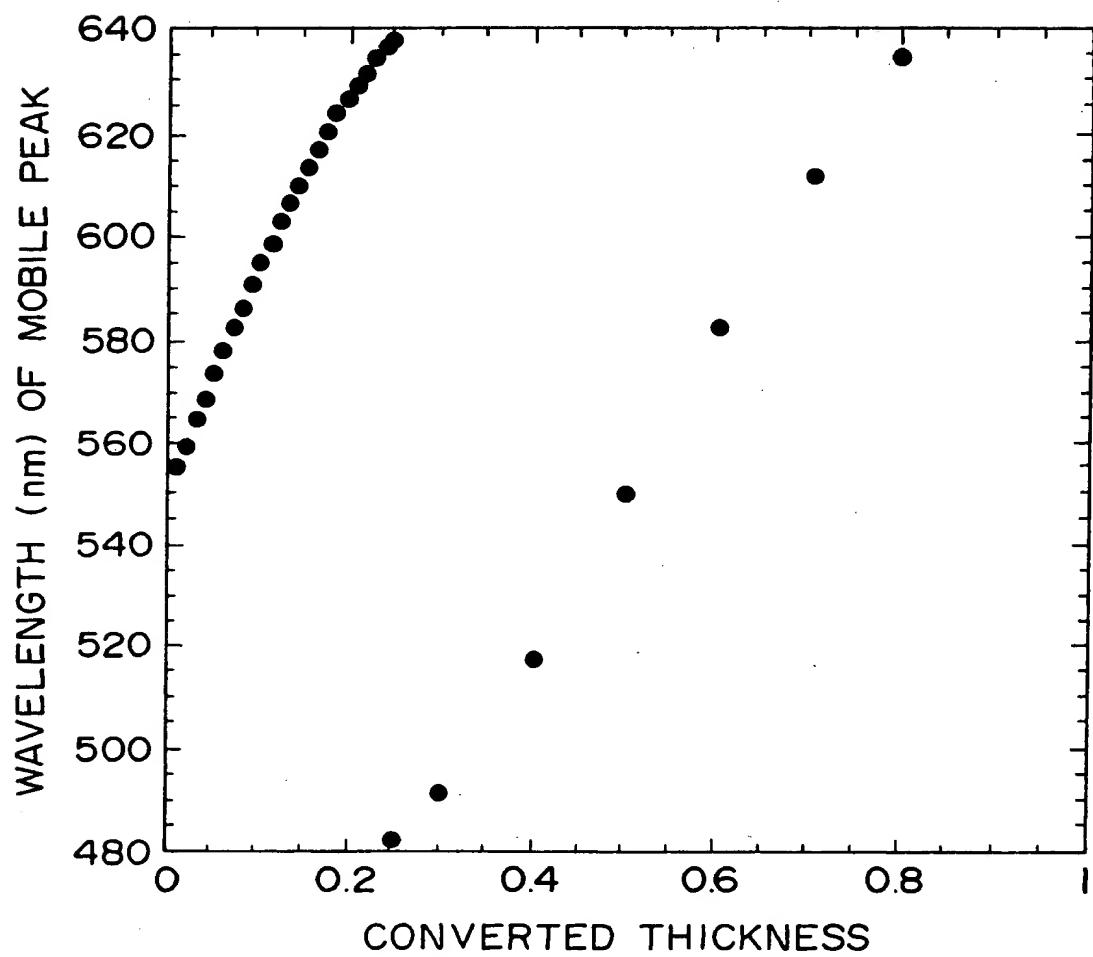
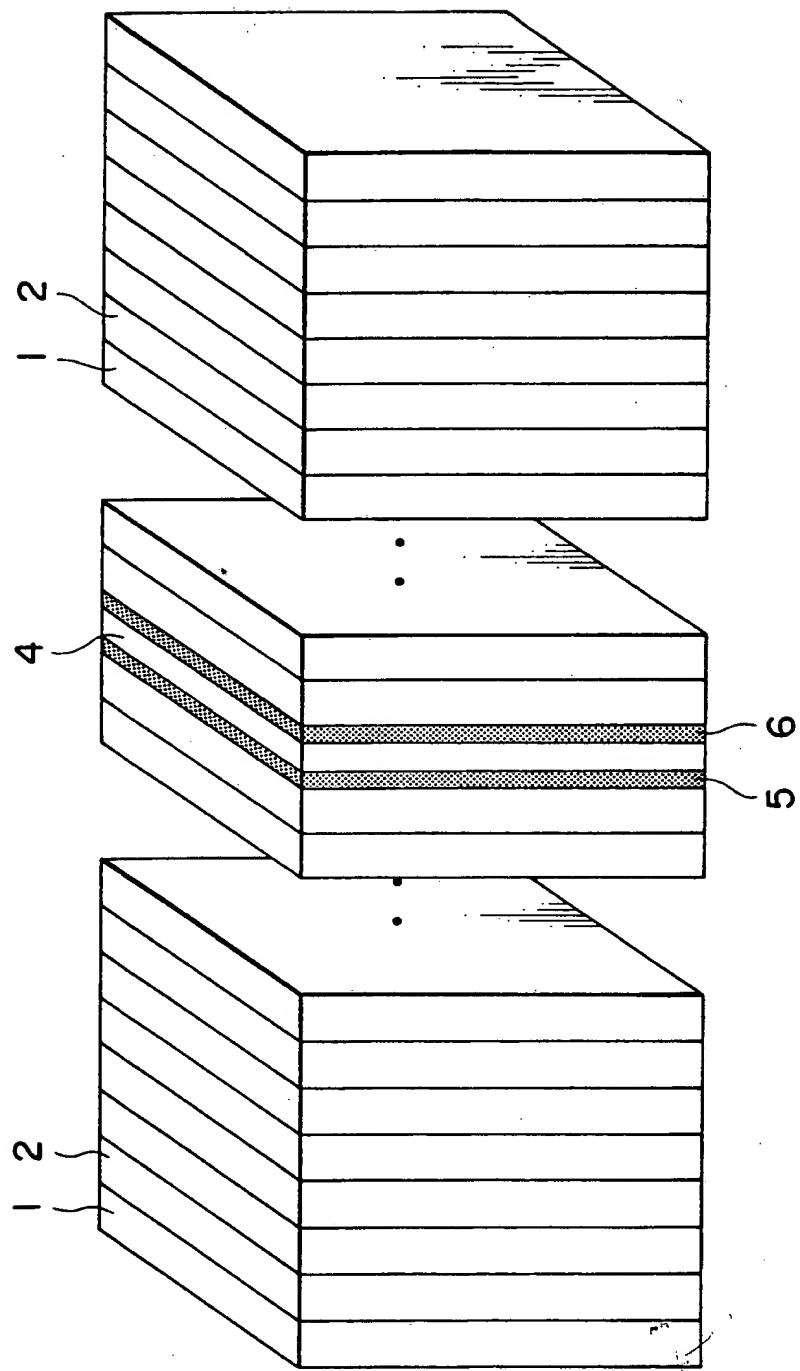
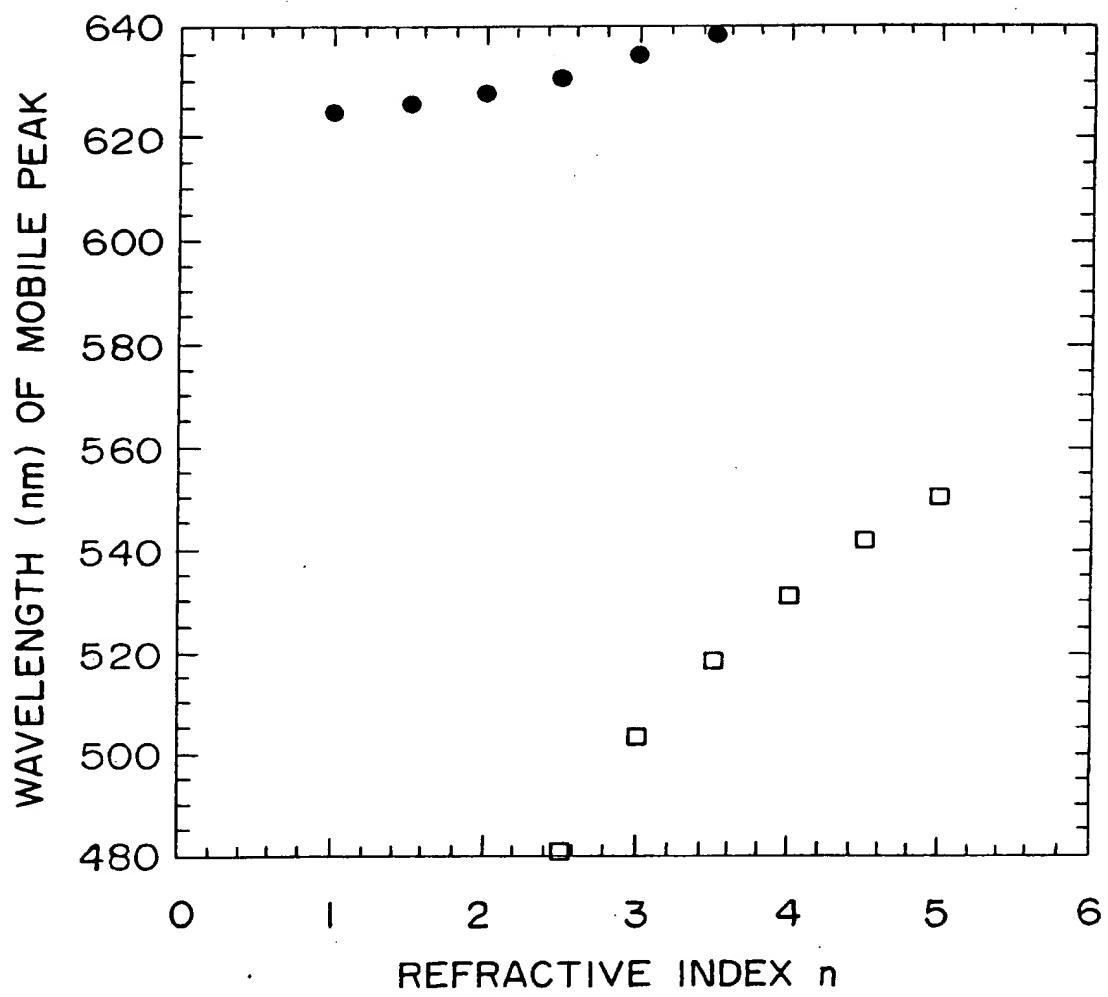


FIG. 10



F I G. I I



F I G. 12

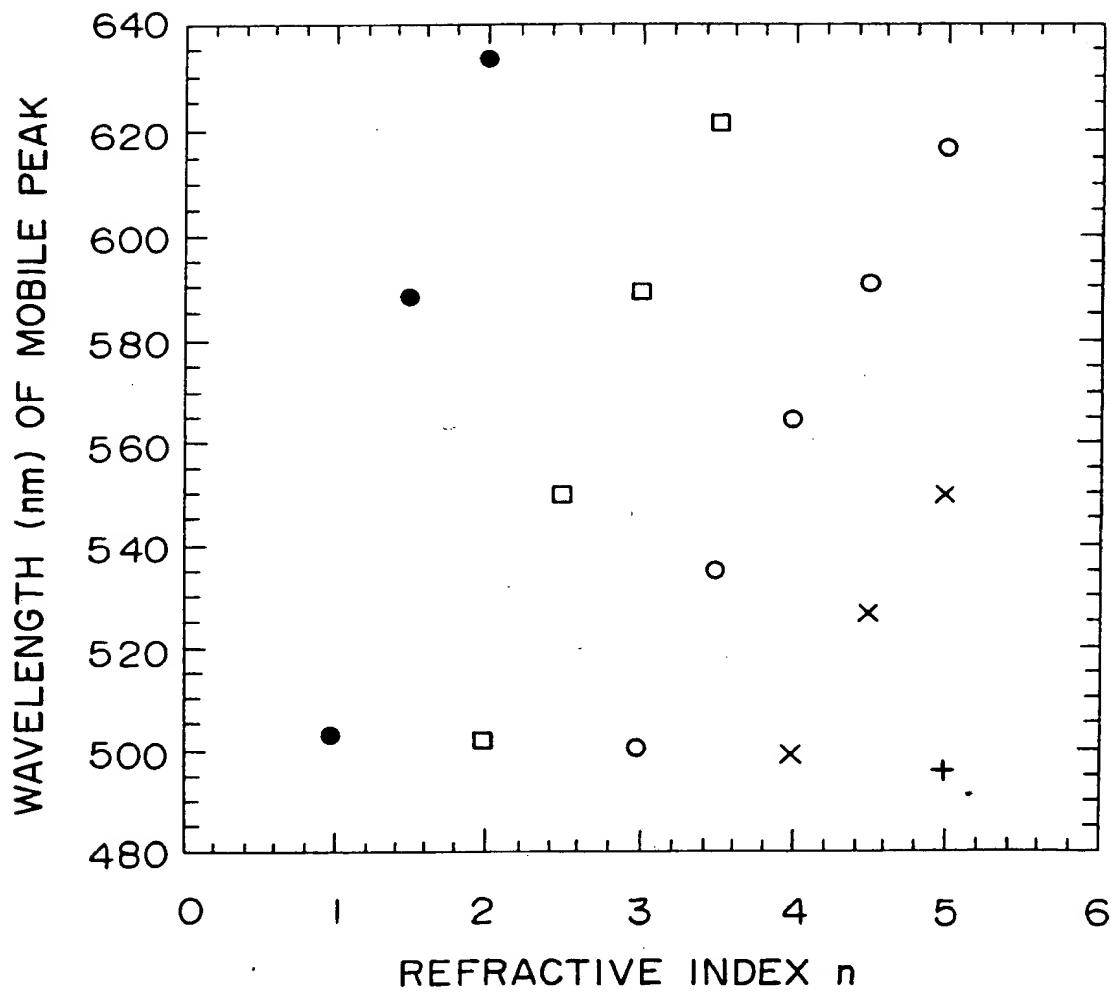


FIG. 13A

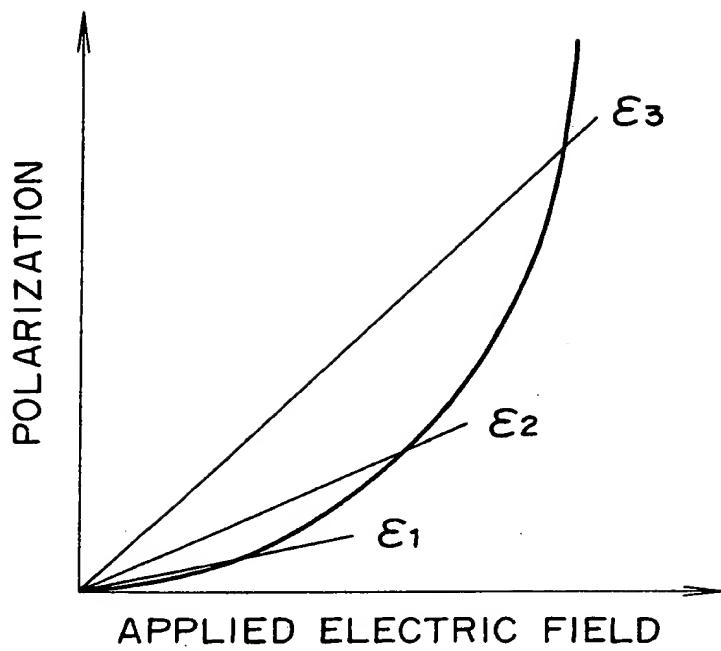


FIG. 13B

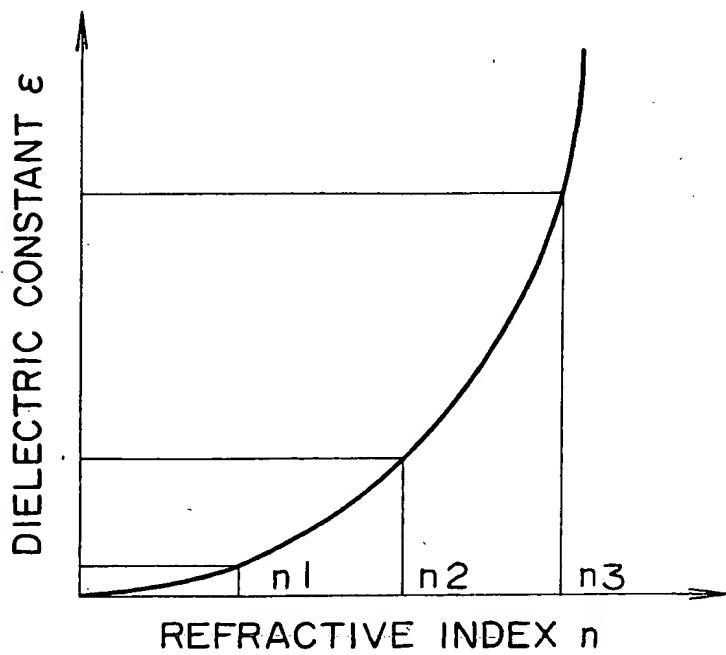
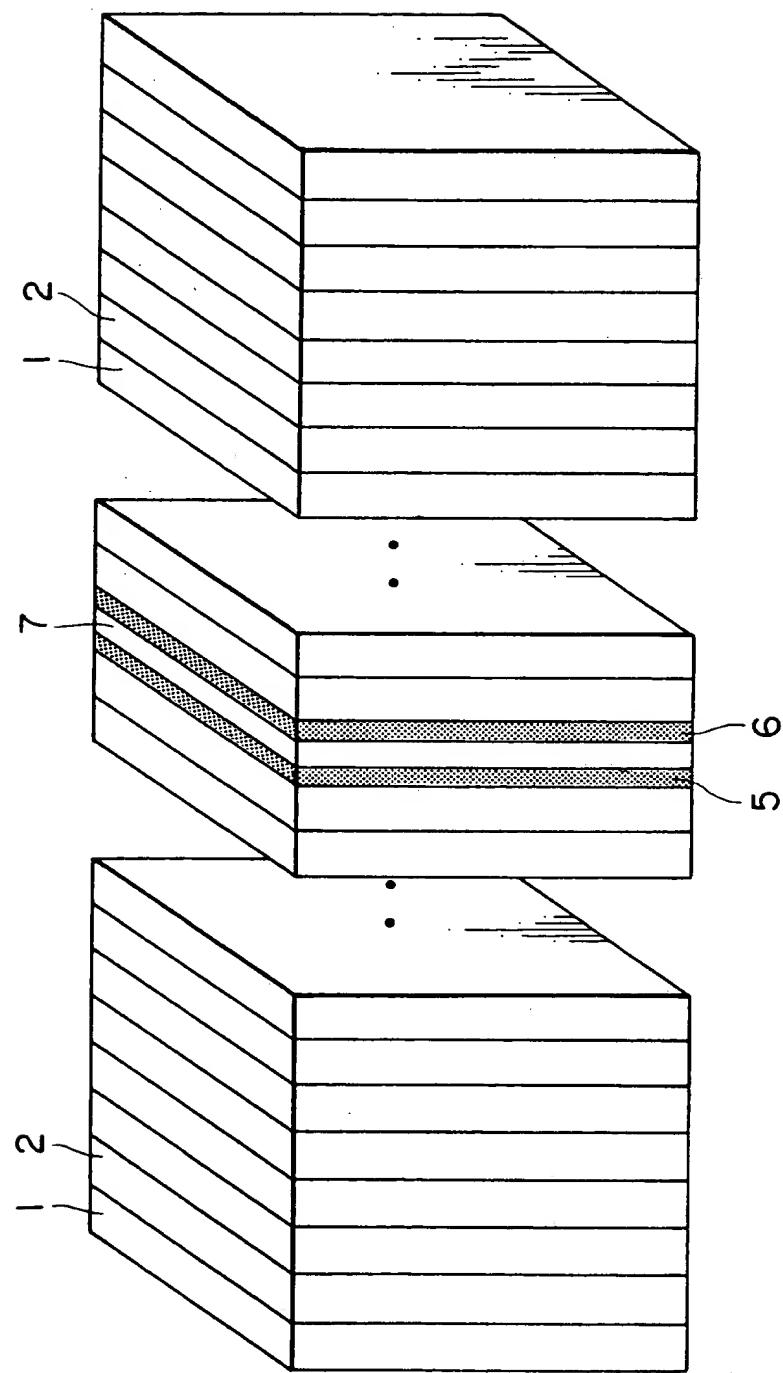
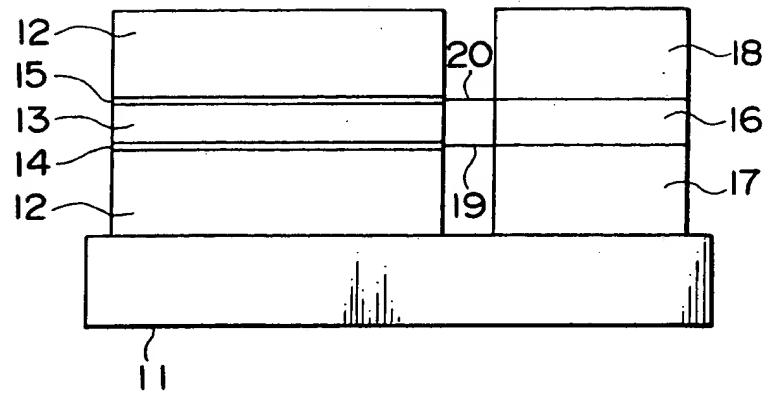


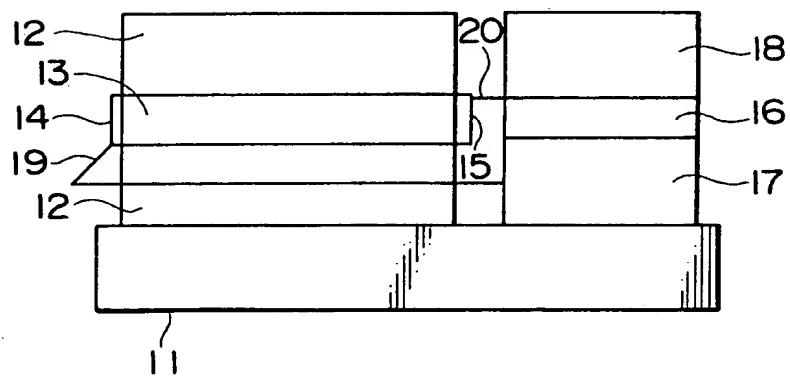
FIG. 14



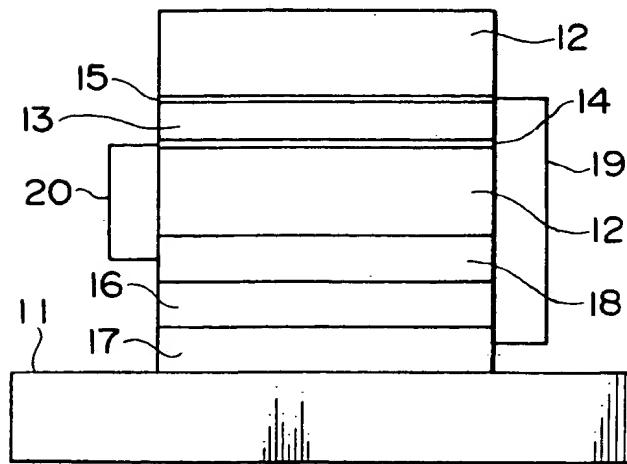
F I G. 15



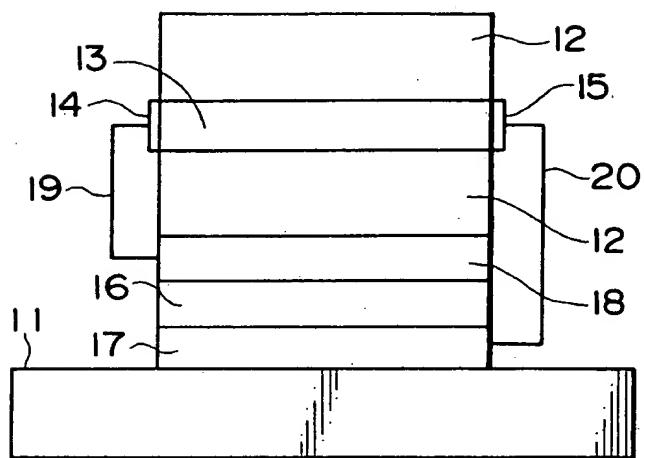
F I G. 16



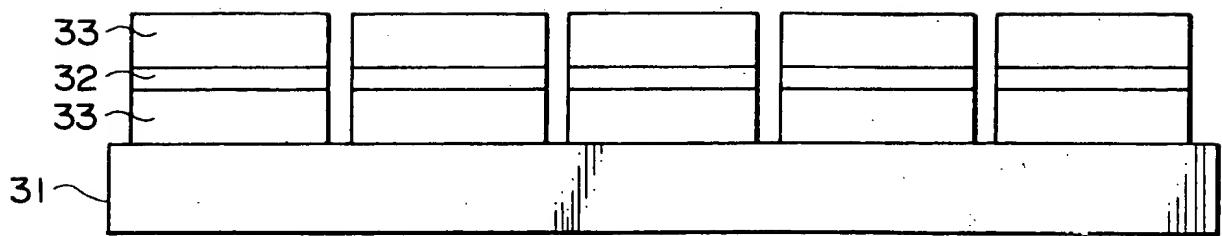
F I G. 17



F I G. 18



F I G. 19



F I G. 20

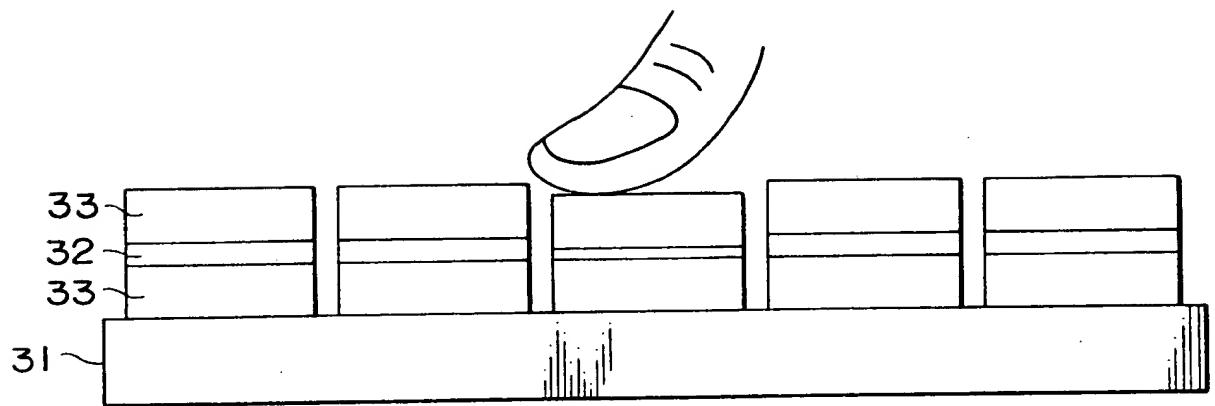
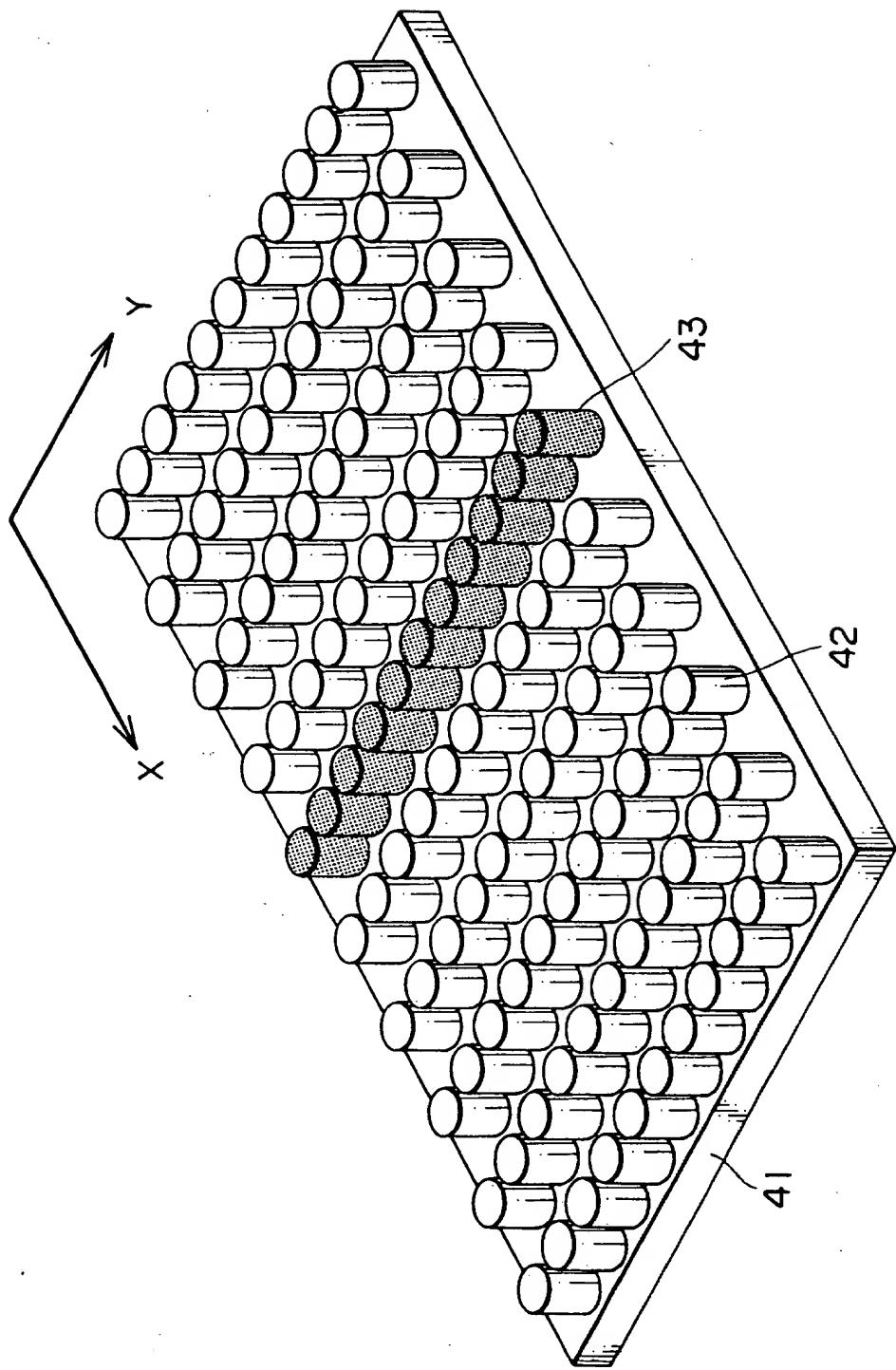
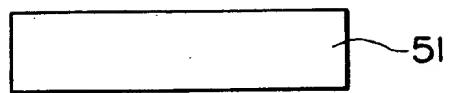


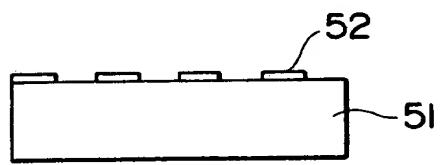
FIG. 21



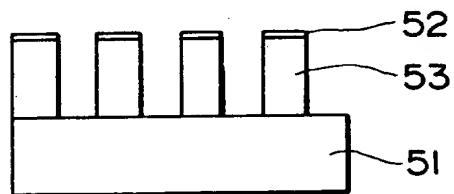
F I G. 22A



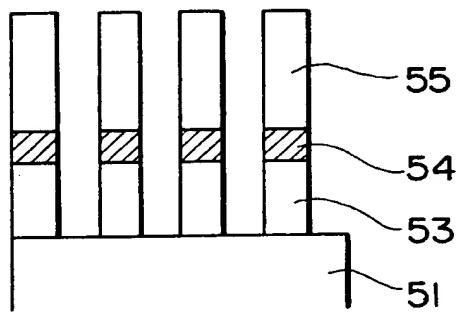
F I G. 22B



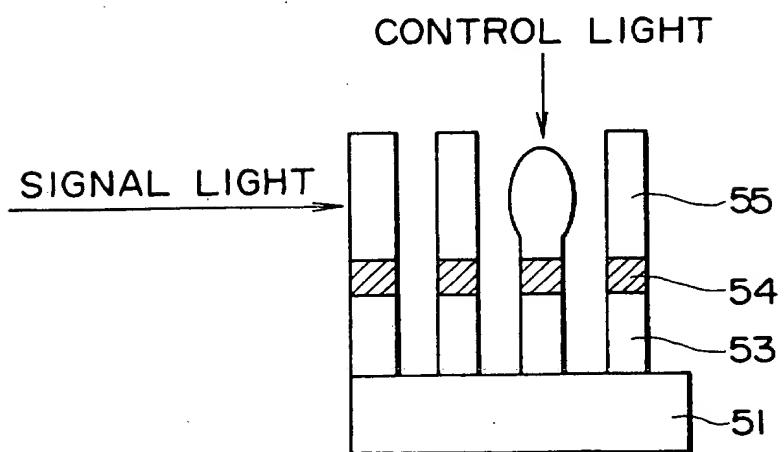
F I G. 22C



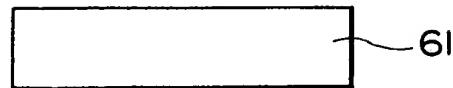
F I G. 22D



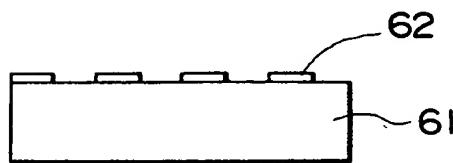
F I G. 23



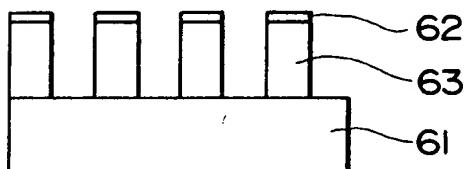
F I G. 24A



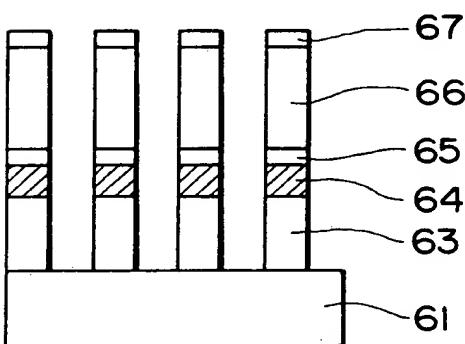
F I G. 24B



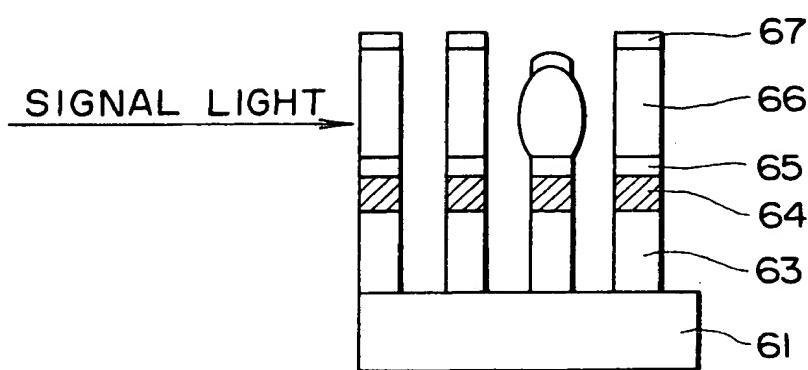
F I G. 24C



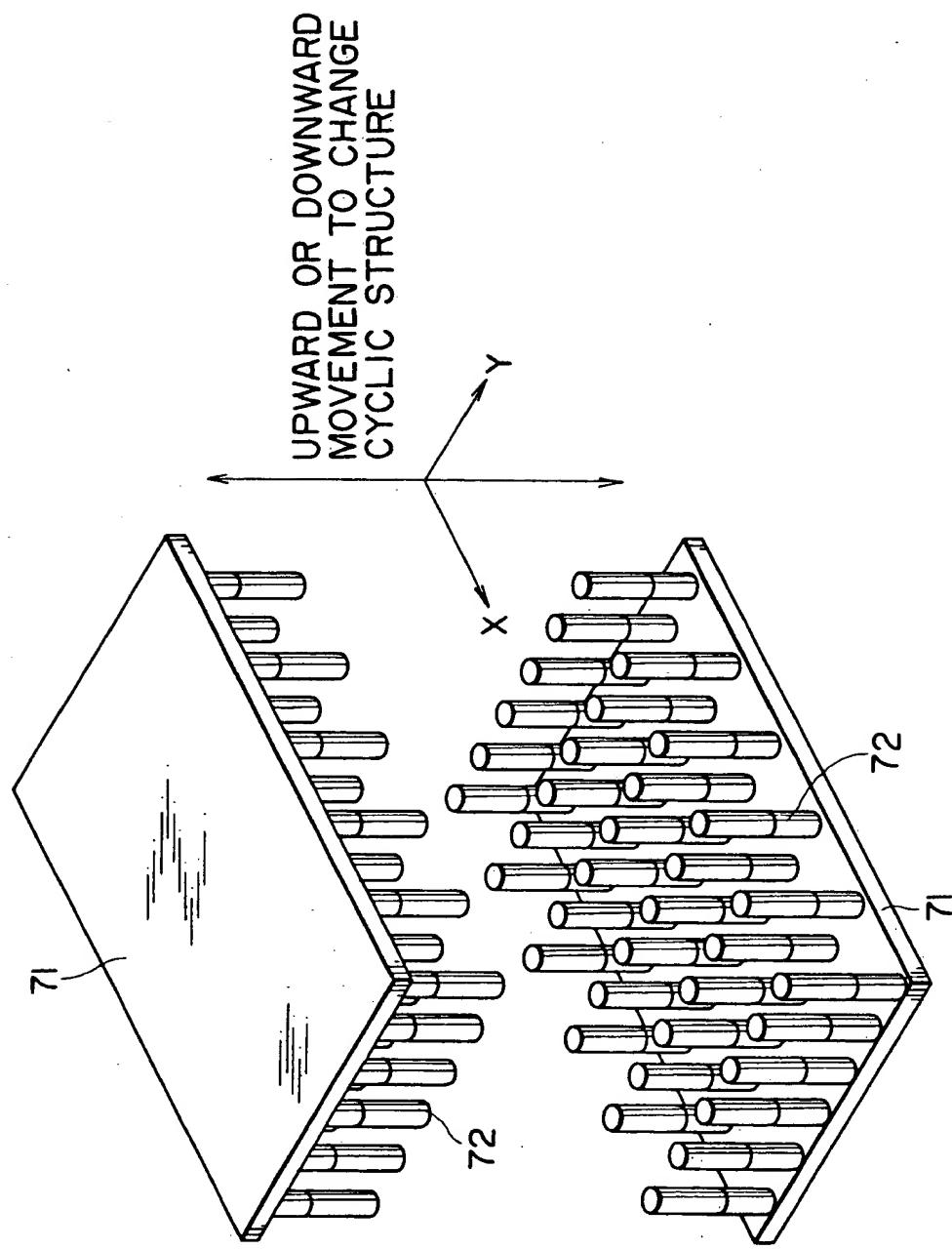
F I G. 24D



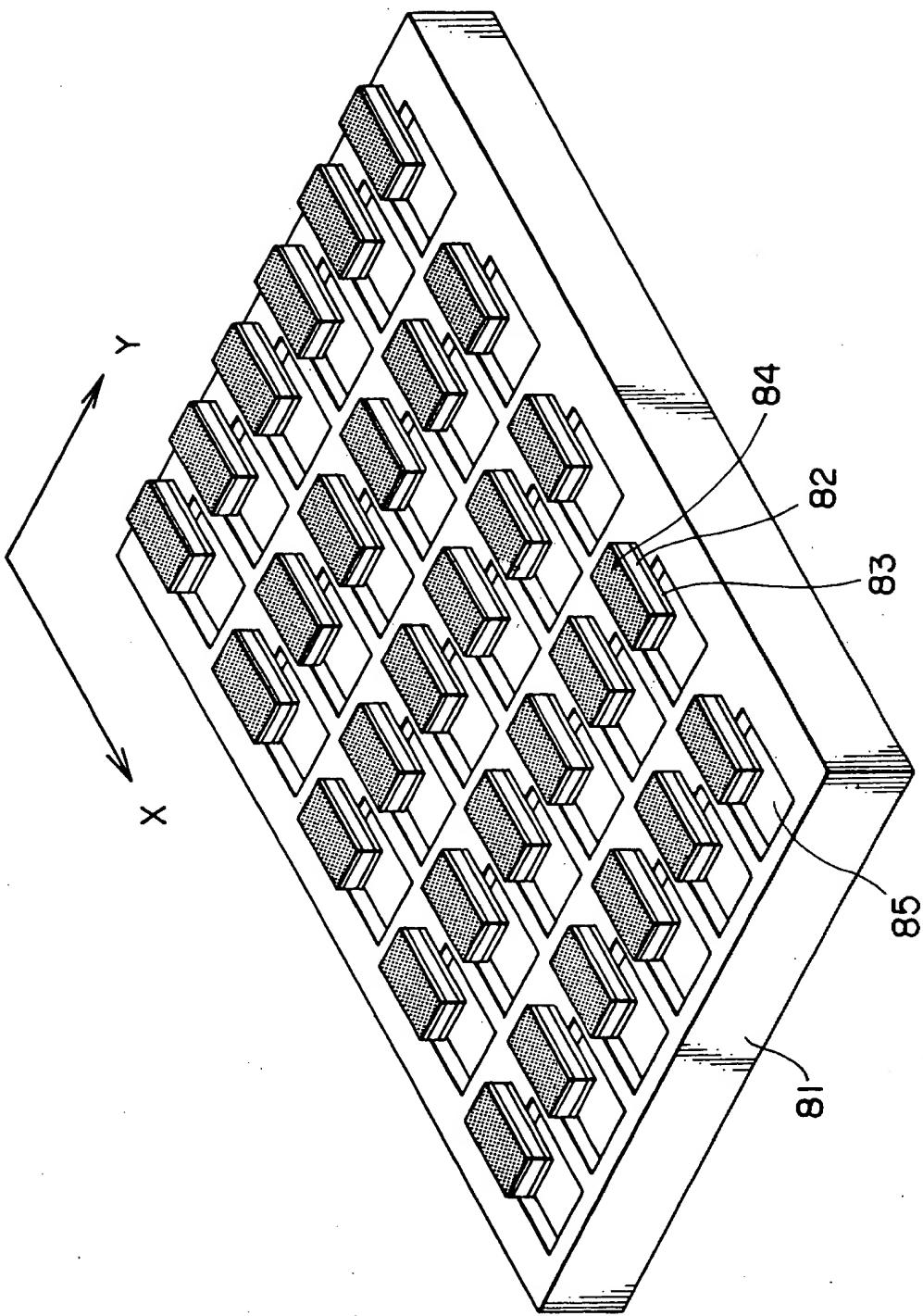
F I G. 25



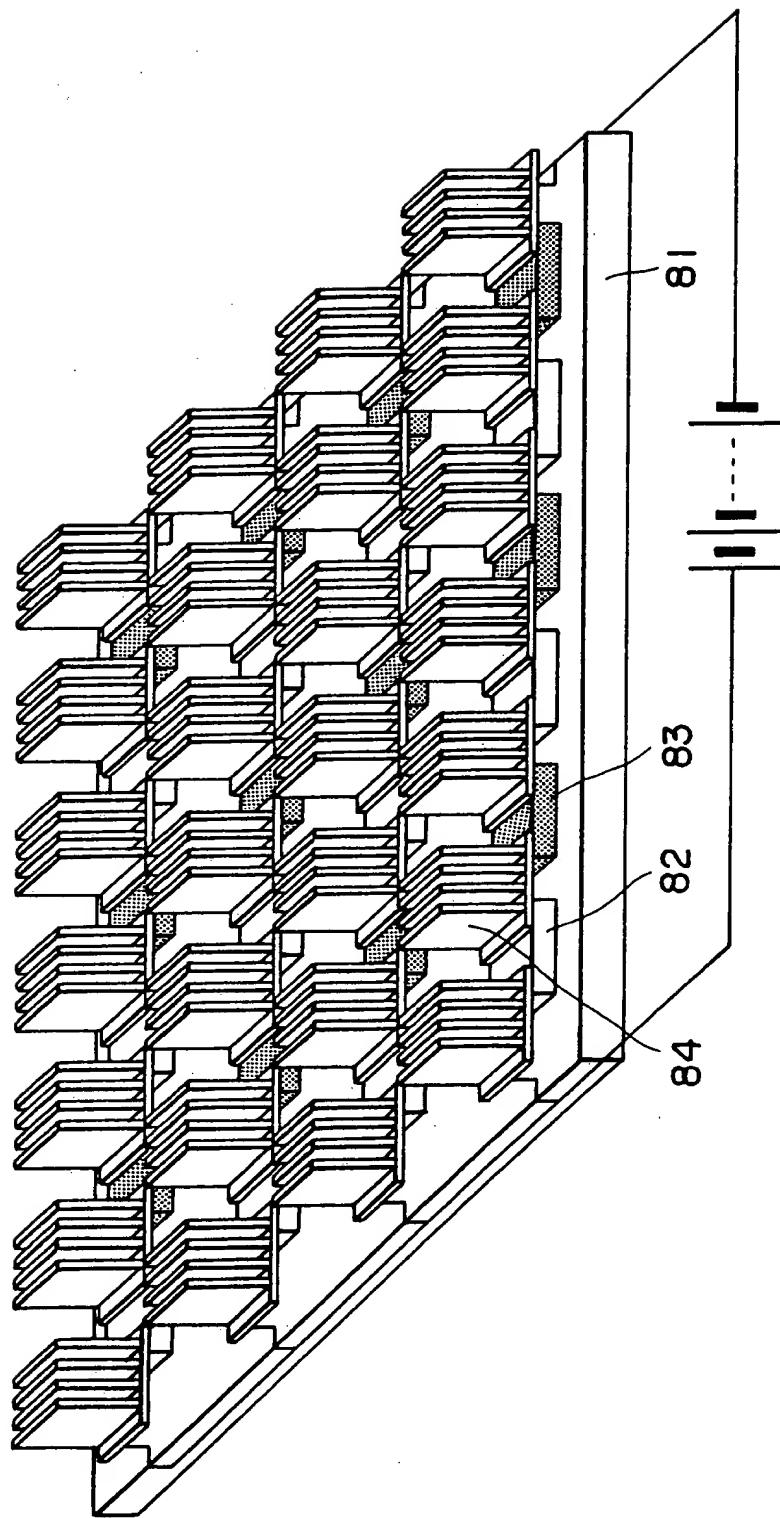
F I G . 26



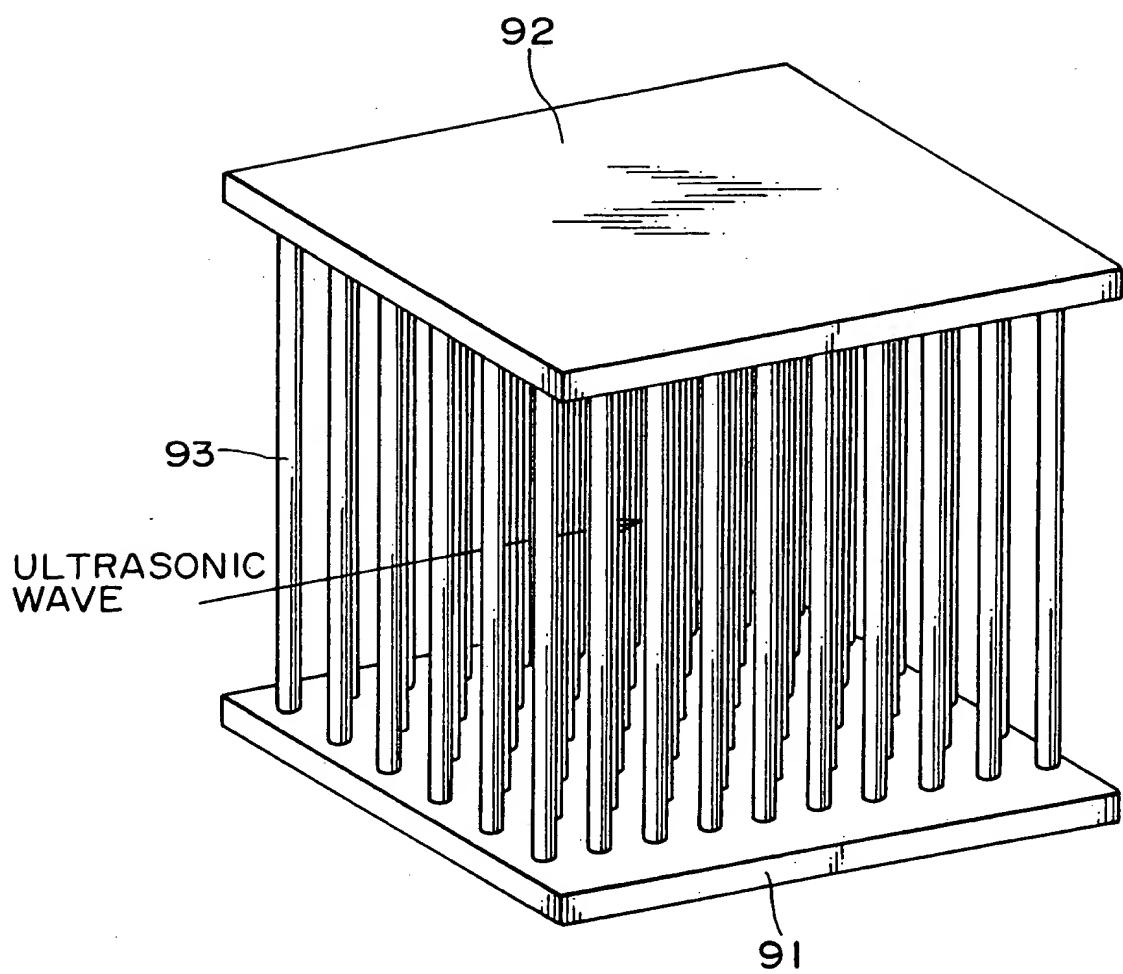
F I G . 27



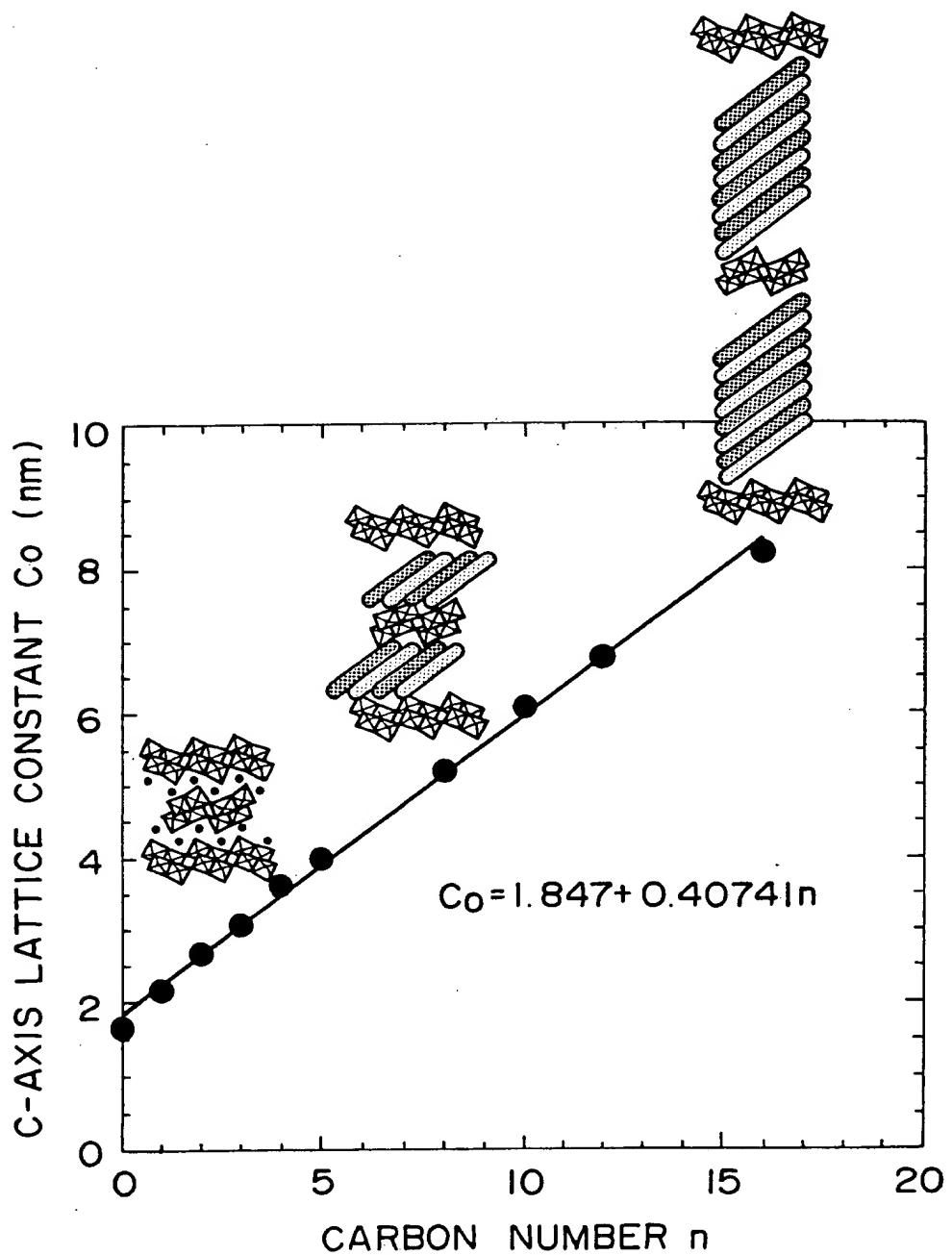
F I G. 28



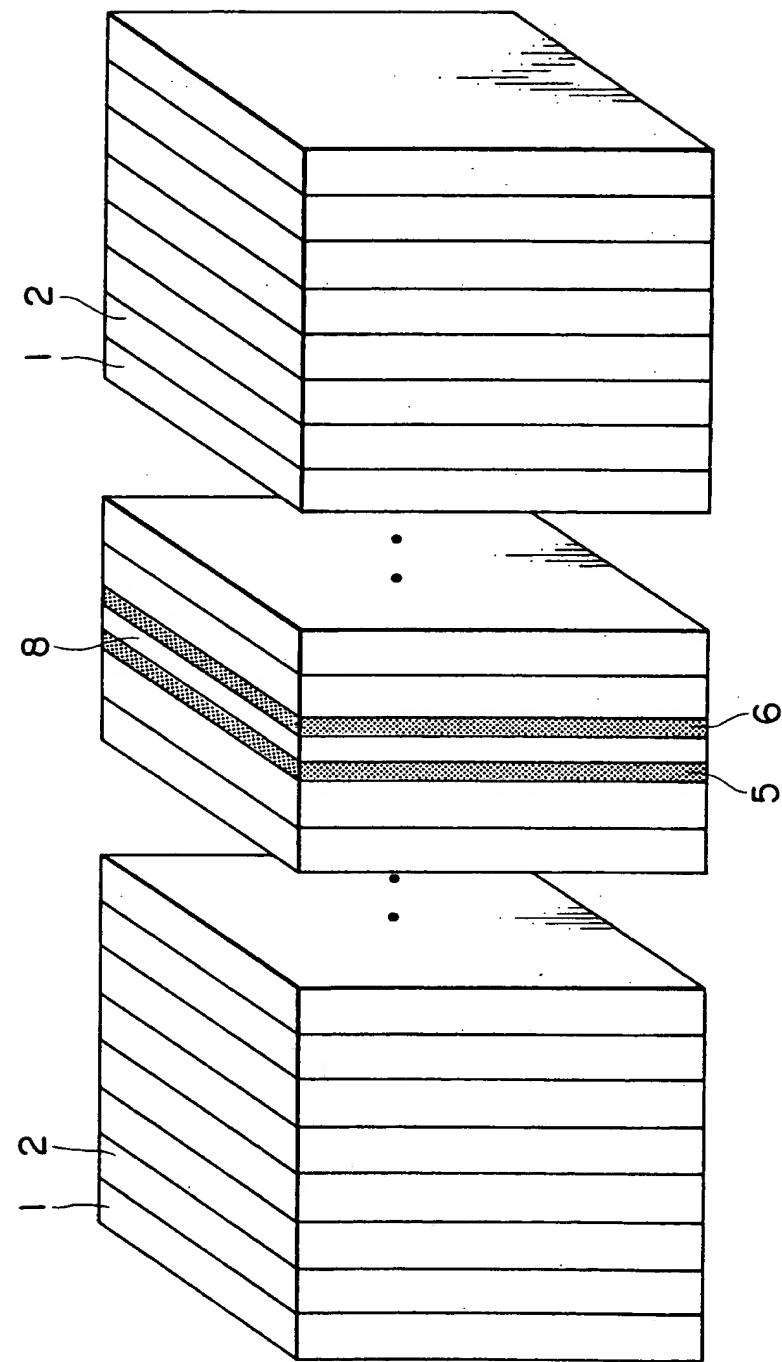
F I G. 29



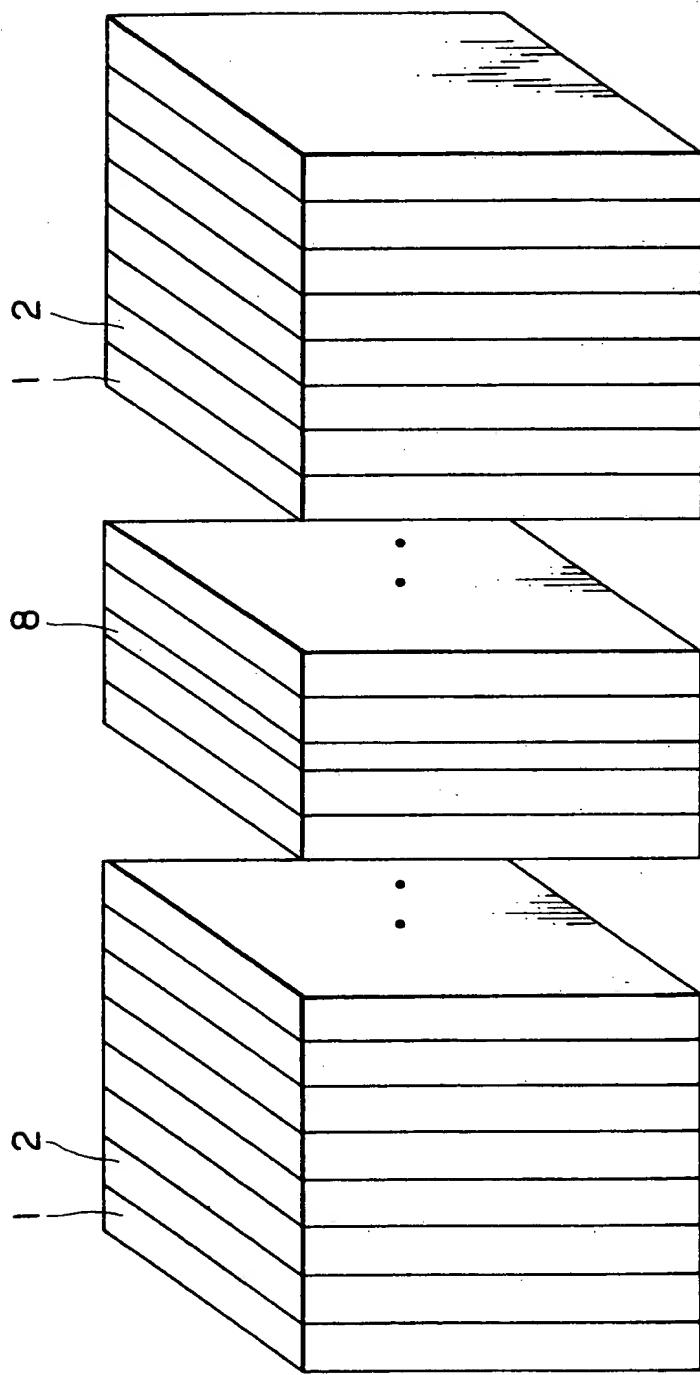
F I G. 30



F | G. 3 |



F | G. 32



F I G . 33

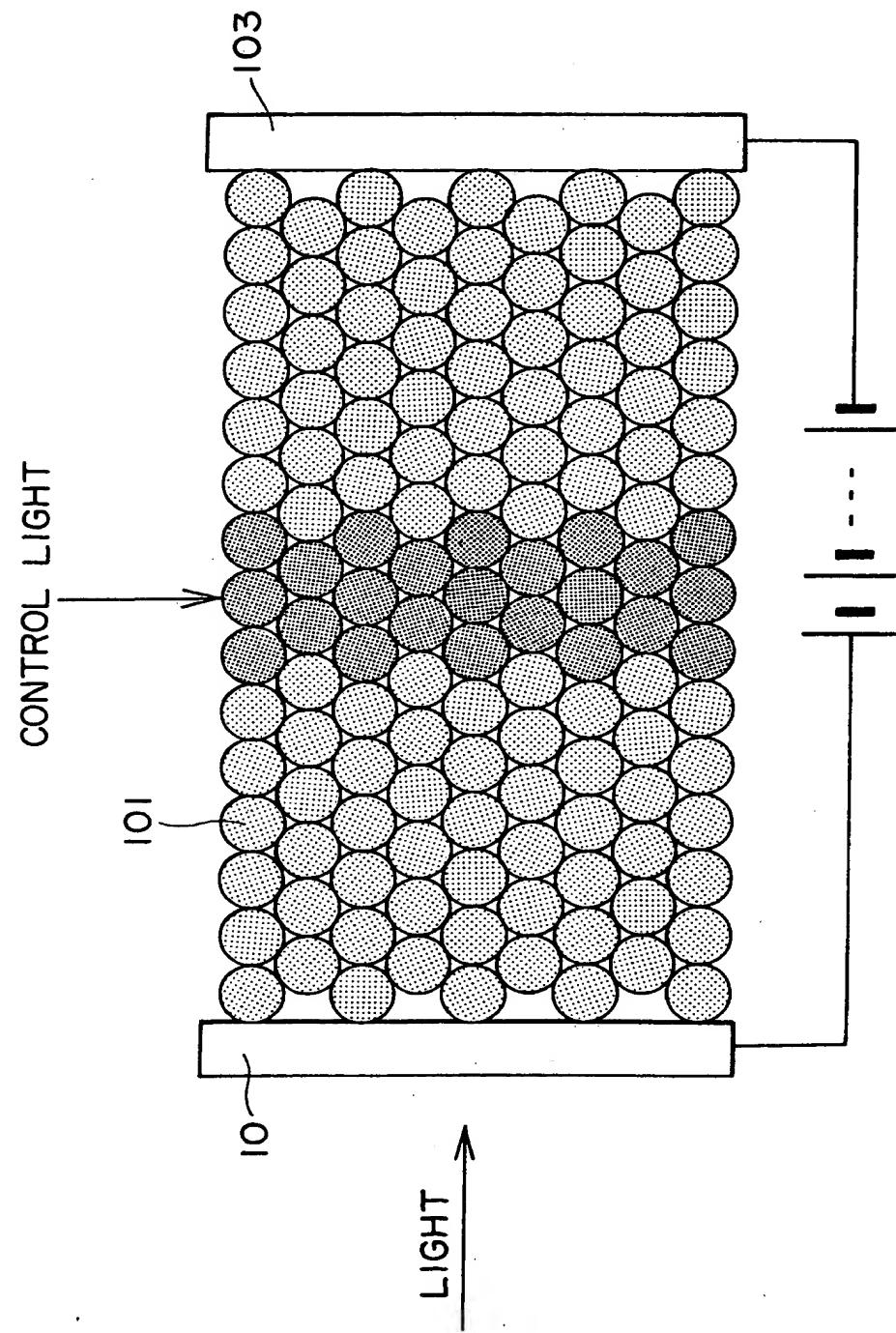


FIG. 34 A

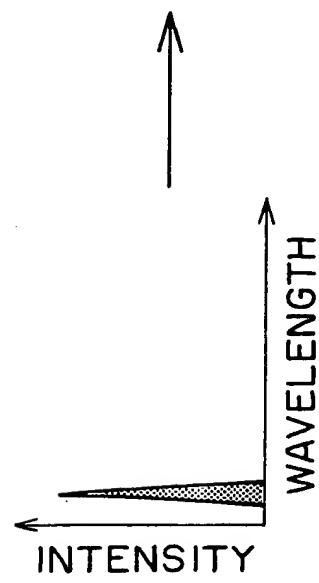


FIG. 34 B

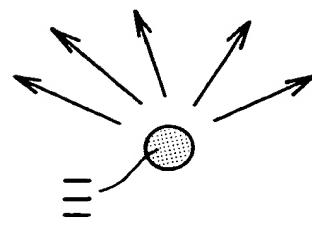


FIG. 34 C

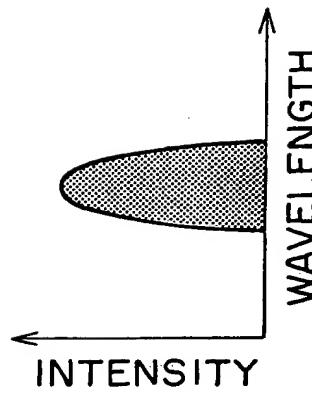


FIG. 35A

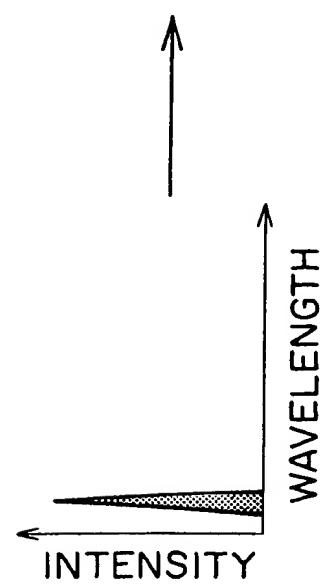


FIG. 35B

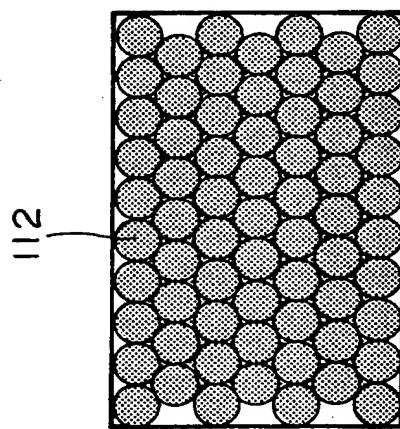


FIG. 35C

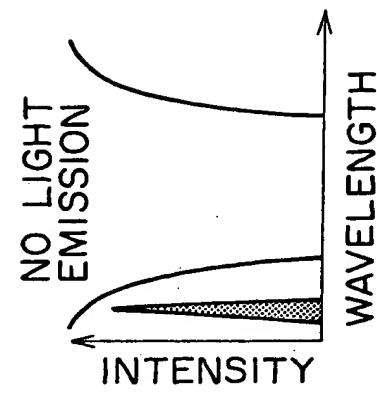


FIG. 36A

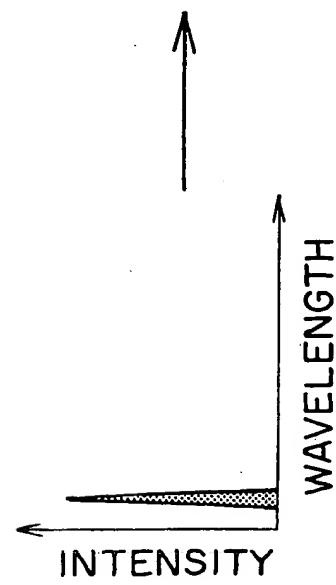


FIG. 36B

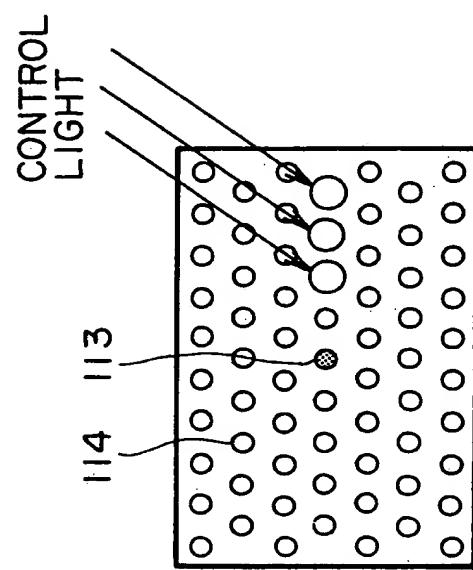
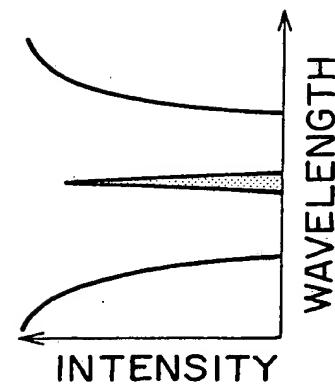


FIG. 36C



F I G. 37

